

# Intestinal helminths of seven species of gekkonid lizards (Sauria: Gekkonidae) from Western Australia

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## Abstract

Two hundred specimens of seven species of geckos collected in Australia were examined for helminths: *Diplodactylus ciliaris*, *Diplodactylus conspicillatus*, *Diplodactylus elderi*, *Diplodactylus pulcher*, *Diplodactylus strophurus*, *Gelyra variegata*, and *Rhynchoedura ornata*. One species of Cestoda (*Oochoristica australiensis*), nine species of Nematoda (*Abbreviata tumidocapitis*, *Maxvachonia brygooi*, *Maxvachonia chabaudi*, *Parapharyugodon kartana*, *Skrjabinelazia machidai*, *Skrjabinodon parasmythii*, *Spauligodon ovifilus*, *Abbreviata* sp (larvae in cysts), *Physaloptera* sp (larvae in cysts)), and a cystacanth of one species of Acanthocephala were found. Eighteen new host records are reported. *Skrjabinelazia machidai* is reported from Australia for the first time.

Keywords: intestinal helminth, gecko, Western Australia

## Introduction

The lizard family Gekkonidae is well represented in Australia; 17 genera with about 102 known species (Cogger 2000). This paper reports helminths from seven species of Australian gekkonid lizards; *Diplodactylus ciliaris* Boulenger 1885, *Diplodactylus conspicillatus* Lucas & Frost 1897, *Diplodactylus elderi* Stirling & Zietz 1893, *Diplodactylus pulcher* (Steindachner 1870), *Diplodactylus strophurus* (Duméril & Bibron 1836), *Gelyra variegata* (Duméril & Bibron 1836) and *Rhynchoedura ornata* Günther 1867. These data are compared with previous reports of helminths harboured by Australian gekkonid lizards.

## Methods

Two hundred geckos from the herpetology collection of the Natural History Museum of Los Angeles County (LACM) were examined for helminths. These specimens had been collected between 1966 and 1968 for an ecological study (Pianka 1972). Because the ecological study included stomach analysis, only small and large intestines remained with the carcasses. Numbers of lizards, mean snout-vent length (SVL), museum accession numbers and collection sites (latitudes, longitudes) are given for each species in the Appendix. Additional collection data are found in Pianka (1972). A helminth species richness analysis (excluding larval helminths) for Australian gekkonid lizards is presented. Lizard taxonomy is according to Cogger (2000).

*Diplodactylus ciliaris* is found in the interior of all mainland Australian states except Victoria; *D. conspicillatus* occurs in coastal and interior regions of Western Australia and the Northern Territory but is confined to interior regions of Queensland, New South Wales and South Australia; *D. elderi* is known from central and southern Western Australia; *D. pulcher* is found in central and southern Western Australia; *D. strophurus* occurs on the central coast and in the interior

of Western Australia; *Gelyra variegata* is found throughout inland eastern and south-eastern Australia and has a separate population in southern Western Australia; *R. ornata* is known from all Australian states (Cogger 2000).

The intestines, body cavity and liver of each lizard were examined for helminths using a dissecting microscope. Each helminth was placed on a glass slide in a drop of undiluted glycerol and examined with a compound microscope. Nematodes were identified from these preparations. Cestodes and acanthocephalans were stained with hematoxylin and mounted in balsam for identification.

## Results

Gravid individuals of one species of Cestoda, *Oochoristica australiensis* Spasskii, 1951 and seven species of Nematoda, *Abbreviata tumidocapitis* Jones 1983; *Maxvachonia brygooi* Mawson 1972; *Maxvachonia chabaudi* Mawson 1972; *Parapharyugodon kartana* (Johnston & Mawson 1941); *Skrjabinelazia machidai* Hasegawa 1984; *Skrjabinodon parasmythii* Mawson 1971; *Spauligodon ovifilus* Bursey & Goldberg 1999 were found. In addition, larvae (in cysts) of *Abbreviata* sp and *Physaloptera* sp as well as a cystacanth of an unidentified species of Acanthocephala were found. Eighteen new host records are noted (Table 1). Prevalence, mean intensity, and range of helminth infection by host are also presented in Table 1. Because physalopterid nematodes normally mature in the stomach (Anderson 2000), and because cysts containing larval physalopterids occasionally occur on stomach walls (Jones 1995a), *Abbreviata tumidocapitis* and larvae of *Abbreviata* sp and *Physaloptera* sp may be under-reported in Table 1.

## Discussion

Helminth records now exist for 17 species of Australian gekkonid lizards and are summarized in Table 2. One species of Trematoda, *Paradistomum crucifer* (Nicoll 1914) Travassos 1919 has been reported to infect the gekkonid

Table 1. Prevalence (%), mean intensity ( $\pm$  se and range in parentheses) for intestinal helminths from seven species of gekkonid lizards from Western Australia, with sample size (n) in parentheses.

Helminth	Diplodactylus ciliaris (n = 31)		Diplodactylus conspiciellatus (n = 32)		Diplodactylus elderi (n = 17)		Diplodactylus pulcher (n = 20)		Diplodactylus strophurus (n = 32)		Gehyra variegata (n = 25)		Rhychoedra ornata (n = 43)	
	%	$\bar{x} \pm se$	%	$\bar{x} \pm se$	%	$\bar{x} \pm se$	%	$\bar{x} \pm se$	%	$\bar{x} \pm se$	%	$\bar{x} \pm se$	%	$\bar{x} \pm se$
<i>Oochoristica australiensis</i>	--	--	*3	2	*6	1	*15	1.7 $\pm$ 0.6 (1-3)	--	--	*8	1	*47	2.6 $\pm$ 0.4 (1-7)
<i>Abbreviata tumidocapitis</i>	--	--	--	--	--	--	*5	1	--	--	--	--	--	--
<i>Maxvachonia brygooi</i>	--	--	--	--	--	--	--	--	--	--	*12	1.3 $\pm$ 0.3 (1-2)	--	--
<i>Maxvachonia cluabaudi</i>	*3	1	--	--	*6	11	--	--	*63	4.7 $\pm$ 1.1 (1-20)	--	--	--	--
<i>Parapharyngodon kartana</i>	*6	1	--	--	--	--	--	--	--	--	*8	--	--	--
<i>Skrjabinielazia machidai</i>	*3	4	--	--	--	--	--	--	--	--	--	--	--	--
<i>Skrjabinodon parasmythii</i>	--	--	--	--	*12	11 $\pm$ 1 (10-12)	--	--	--	--	*8	1	--	--
<i>Spauligodon ovifilus</i>	--	--	*28	6.8 $\pm$ 3 (1-29)	--	--	*30	5 $\pm$ 1.8 (1-12)	--	--	--	--	*7	2.7 $\pm$ 0.3 (2-3)
<i>Abbreviata</i> sp (larvae)	3	2	9	1.3 $\pm$ 0.3 (1-2)	--	--	5	6	--	--	8	1	5	1
<i>Physaloptera</i> sp (larvae)	--	--	16	1	--	--	--	--	--	--	--	--	--	--
acanthocephalan cystacanth	--	--	3	1	--	--	--	--	--	--	--	--	--	--

\* new host record

*Christinus marmoratus* as well as the scincids *Hemiergis peronii*, *Lerista bougainvillii*, *Trachydosaurus rugosus* and *Tiliqua scincoides*, the pygopodid *Delma fraseri*, and the varanid *Varanus varius* (Nicoll 1914; Angel & Mawson 1968; Mawson 1971).

Three species of cestodes have been reported from Australian geckos: *Cylindrotaenia allisonae* (Schmidt 1980) Jones 1987 from *Heteronotia binocci*; *Oochoristica australiensis* Spasskii 1951 from *Diplodactylus conspicillatus*, *D. elderi*, *D. pulcher*, and *Rhynchoedura ornata*; *Oochoristica piankai* Bursey, Goldberg & Woolery 1996 from *Nephrurus laevis* (see Pichelin *et al.* 1999 for localities). These three cestode species are known to occur in other lizard families. Angel & Mawson (1968) reported *C. allisonae* to also occur in the scincids *Hemiergis peronii* and *Lerista bougainvillii*; Spasskii (1951) described *Oochoristica australiensis* from the scincid *Trachydosaurus rugosus*; and Bursey *et al.* (1996) described *Oochoristica piankai* from the agamid *Molloch horridus*. In

addition, there is a report by Angel & Mawson (1968) of an unidentified species of *Oochoristica* from the gekkonid *Christinus marmoratus*.

Two species of acanthocephalans have been reported from Australian lizards: *Porrrochilus hylae* (Johnston 1914) Schmidt & Kuntz 1967 from the pygopodid *Lialis burtonis* and *Sphaerechinorhynchus rotundocapitatus* (Johnston 1912) Johnston & Deland 1929 from the scincids *Eulamprus quoyii*, *Hemiergis decresiensis*, *Lampropholis guichenoti* and the varanid *Varanus varius* (see Pichelin *et al.* 1999 for localities). Acanthocephalan cystacanths (unidentified as to species) have also been reported from the scincid *Hemiergis peronii*, collected in South Australia by Angel and Mawson (1968). This is the first report of a cystacanth in an Australian gekkonid. Because this larva does not mature in lizards, we have excluded it from Table 2.

Seventeen species of nematodes have now been re-

Table 2. Helminth parasites recorded for gekkonid lizards from Australia.

Host	<i>Paradistomum crucifer</i>	<i>Cylindrotaenia allisonae</i>	<i>Oochoristica australiensis</i>	<i>Oochoristica piankai</i>	<i>Oochoristica</i> sp.	<i>Abbreviata bancrofti</i>	<i>Abbreviata tumidocapitis</i>	<i>Maxvachonia brygooi</i>	<i>Maxvachonia chabaudi</i>	<i>Parapharyngodon kartana</i>	<i>Pharyngodon kartana</i>	<i>Pharyngodon tiliquae</i>	<i>Physalopteroides filicauda</i>	<i>Skrjabinelaziz machidai</i>	<i>Skrjabinelaziz</i> sp.	<i>Skrjabinodon oedurae</i>	<i>Skrjabinodon parasmythii</i>	<i>Skrjabinodon piankai</i>	<i>Skrjabinodon smythii</i>	<i>Skrjabinoptera goldmanae</i>	<i>Spauligodon ocelliflus</i>	<i>Wanaristongylus ctenoti</i>	<i>Wanaristongylus papangawurpae</i>
<i>Christinus guentheri</i>	-	-	-	-	-	-	-	-	-	1,2	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Christinus marmoratus</i>	2	-	-	-	3	-	-	-	-	3	-	-	-	2,3	-	2	-	3	-	-	-	-	-
<i>Diplodactylus ciliaris</i>	-	-	-	-	-	-	-	-	4	4	-	5	4	-	-	-	-	-	-	-	-	-	-
<i>Diplodactylus conspicillatus</i>	-	-	4	-	-	-	5	-	-	-	-	5	-	-	-	-	-	-	-	-	4	5	
<i>Diplodactylus elderi</i>	-	-	4	-	-	-	-	-	4	-	-	5	-	-	-	-	4	-	-	-	-	-	
<i>Diplodactylus pulcher</i>	-	-	4	-	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-	
<i>Diplodactylus stenodactylus</i>	-	-	-	-	-	-	-	-	-	-	-	5	-	-	-	-	-	-	-	-	6	6	
<i>Diplodactylus strophurus</i>	-	-	-	-	-	-	-	-	4	-	-	5	-	-	-	-	-	-	-	-	-	-	
<i>Gehyra variegata</i>	-	-	4	-	-	-	-	4	4	-	1	5	-	-	-	4	-	-	5	-	-	-	
<i>Heteronotia binocci</i>	-	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
<i>Nephrurus laevis</i>	-	-	-	8	-	-	-	-	-	-	-	5,8	-	-	-	-	8	-	-	-	-	5,9	
<i>Nephrurus levis</i>	-	-	-	-	-	-	-	8	-	-	-	8	-	-	-	-	8	-	-	-	5,8	-	
<i>Nephrurus vertebralis</i>	-	-	-	-	-	-	-	-	-	-	8	-	-	-	-	-	8	-	-	-	-	-	
<i>Oedura robusta</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10	-	-	-	-	-	-	-	
<i>Phyllurus platurus</i>	-	-	-	-	-	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
<i>Rhynchoedura ornata</i>	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-	
<i>Underwoodisaurus milii</i>	-	-	-	-	-	-	-	12	-	2	-	-	-	-	-	-	-	-	2	-	-	-	

1, Johnston & Mawson 1943; 2, Mawson 1971; 3, Angel & Mawson 1968; 4, this paper; 5, H Jones 1995b; 6, Bursey & Goldberg 1999b; 7, M Jones 1987; 8, Bursey & Goldberg, 1999a; 9, H Jones 1987; 10, Johnston & Mawson 1947; 11, Irwin-Smith 1922; 12, Mawson 1972.

ported from Australian geckos (Table 2). Of these, eleven species: *Abbreviata bancrofti*, *Abbreviata tumidocapitis*, *Maxvachonia brygooi*, *Maxvachonia chnbaudi*, *Parapharyngodon kartana*, *Pharyngodon kartana*, *Pharyngodon tiliquae*, *Physalopteroides filicauda*, *Skrjabinoptera goldmanae*, *Wanaristrongylus ctenoti*, *Wanaristrongylus papangawurpae* are generalists that have previously been reported from various lizard and snake families (Pichelin *et al.* 1999). Five species are known only from Australian geckos (*Skrjabinodon oedurae*, *S. parasmythi*, *S. piangkai*, *S. smythi*, *Spauligodon ovifilus*). The remaining species, *Skrjabinelazia machidai*, was known only from non-Australian geckos: *Gekko japonicus* in Okinawa (Hasegawa 1984); *Lepidodactylus lugubris* in Hawaii (Goldberg & Bursey 1997). Australia is a new locality record for *Skrjabinelazia machidai*. It should be noted that female nematodes assigned to *Skrjabinelazia* sp. have previously been reported from the gekkonid *Christinus guentheri* by Angel & Mawson (1968) and Mawson (1971) and the scincid *Ctenotus schomburgkii* by Goldberg & Bursey (1995). Male and female specimens in the current study were consistent with those described by Hasegawa (1984) as *S. machidai*. The female specimens examined here are indistinguishable from those found in *C. schomburgkii* by Goldberg & Bursey (1995).

Encysted larvae assigned to the genera *Abbreviata* and *Physaloptera* as well as encysted larvae assigned to the family Physalopteridae have also been reported from Australian gekkonids, *Christinus marmoratus*, *Diplodactylus ciliaris*, *D. conspicillatus*, *D. elderi*, *D. stenodactylus*, *D. strophurus*, *Gehyra variegata*, *Nephruerus laevissimus*, *N. levis*, *Oedura robusta* and *Rhychoedura ornata* (Jones 1992, 1995a, 1995b; Bursey & Goldberg 1999a). Physalopterid larvae have been reported from agamid, pygopodid, scincid and varanid lizards (Jones 1995a). Mature individuals of fifteen species of *Abbreviata* have been found in Australian reptiles (Pichelin *et al.* 1999). However, adults of species of *Physaloptera* are not known as parasites of Australian reptiles although adults of seven species are known from Australian mammals, five from marsupials and two from native rodents (Norman & Beveridge 1999). Roca (1993) suggested that prevalence of encysted larval nematodes in a lizard population indicates their degree of importance as prey because lizards can serve as intermediate hosts. Species of *Physaloptera* require an insect intermediate host (Anderson 2000). Further study will be necessary to determine whether geckos serve as intermediate hosts or accidentally acquire physalopterid larvae as a consequence of diet. Because these larvae were in cysts, we have excluded them from Table 2.

The species richness of helminth parasites for seven species of Australian geckos,  $2.57 \pm 0.37$  se (range 1-4) is not significantly different (ANOVA,  $F_{1,12} = 0.22$ ,  $P > 0.05$ ) from the  $2.29 \pm 0.47$  (range 1-4) reported for seven species of Australian agamids (Goldberg *et al.* 2000). These values are greater than the  $2.06 \pm 0.13$  se, range 0-5) for lizards in general (Aho 1990), but they fall within the 95% confidence interval calculated for these lizards. Helminth records now exist for 17 of 102 (17%) Australian geckos. Subsequent examination of additional species will be needed before the helminth diversity of Australian geckos can be determined.

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- 132°06'E). USNPC # 89447 *Oochoristica australiensis*; USNPC # 89448 *Spauligodon ovifilus*; USNPC # 89449 *Abbreviata* sp (larvae); USNPC # 89450 *Physaloptera* sp (larvae); USNPC # 89451 *acanthocephalan cystacanth*.
- *Diplodactylus elderi* (N = 17, Mean SVL = 43 mm ± 0.7 se, range = 38-47 mm) collected 1967-1968, Western Australia LACM (56762, 28°09'S, 123°05'E), (56763-56765, 26°14'S, 121°13'E), (56769, 56770, 56772-56774, 56777-56779, 56781, 28°27'S, 119°05'E) (56784-56787, 28°43'S, 118°38'E). USNPC # 89444 *Oochoristica australiensis*; USNPC # 89445 *Maxvachonia chabandi*; USNPC # 89446 *Skrjabinodon parasmythii*.
  - *Diplodactylus pulcher* (N = 20, Mean SVL = 54 mm ± 0.9 se, range = 48-62 mm) collected 1967-1968, Western Australia, LACM (56930-56932, 56935-56941, 56943, 28°27'S, 119°05'E), (56944, 30°55'S, 125°37'E), (56945, 56946, 29°05'S, 121°22'E), (56947-56950, 27°5'S, 119°37'E), (56951, 56952, 28°43'S, 118°38'E). USNPC # 89452 *Oochoristica australiensis*; USNPC # 89454 *Abbreviata tumidocapitis*; USNPC # 89455 *Spauligodon ovifilus*; USNPC # 89456 *Abbreviata* sp (larvae).
  - *Diplodactylus strophurus* (N = 32, Mean SVL = 65 mm ± 1.5 se, range = 47-85 mm) collected 1967-1968, Western Australia, LACM (56671, 28°23'S, 119°05'E), (56676, 56677, 28°00'S, 120°19'E), (56678-57780, 28°27'S, 119°05'E), (56681, 56683-56685, 56689, 26°14'S, 121°13'E), (56990, 28°08'S, 123°55'E), (56991, 28°09'S, 123°56'E), (56992, 28°05'S, 124°15'E), (56993, 56694, 56696-56699, 56703-56711, 28°27'S, 119°05'E), (56713, 56715, 26°14'S, 121°13'E) (56718, 28°43'S, 118°38'E). USNPC # 89457, *Maxvachonia chabandi*.
  - *Gehyra variegata* (N = 25, Mean SVL = 44 mm ± 1.1 se, range = 35-58 mm) collected 1966-1968, Western Australia, LACM (57603, 57604, 25°47'S, 117°20'E), (57605, 30°05'S, 125°37'E), (57608, 57609, 57611, 28°19'S, 123°27'E); Northern Territory, LACM (57593, 57594, 25°59'S, 113°10'E), (57596, 57597, 22°49'S, 113°23'E), (57598-57599, 22°07'S, 131°21'E), (57613, 23°21'S, 129°22'E), (57614, 21°24'S, 130°53'E), (57615, 20°38'S, 130°25'E), (57622, 57626-57632, 57635, 27°05'S, 119°37'E), (57642, 28°47'S, 118°27'E). USNPC # 89458, *Oochoristica australiensis*; USNPC # 89459, *Maxvachonia brygooi*; USNPC # 89460, *Parapharyngodon kartana*; USNPC # 89461, *Skrjabinodon parasmythii*; USNPC # 89462 *Abbreviata* sp (larvae).
  - *Rhynchoedura ornata* (N = 43, Mean SVL = 48 mm ± 0.8 se, range = 23-55 mm) collected 1967-1968, Western Australia, LACM (57661, 57674, 57675, 57679, 57681, 57684, 57685, 57702, 57712, 57721-57723, 57728, 57738, 57740, 57756, 57768, 28°27'S, 119°05'E), (57773, 57789, 57792, 28°28'S, 122°50'E), (57814, 28°31'S, 122°45'E), (57819, 57821, 57824, 57835, 57840, 57843, 28°30'S, 125°50'E), (57855, 57858, 57860, 26°17'S, 121°00'E), (57865, 57871, 57872, 57875, 28°17'S, 125°40'E), (57884, 57887, 28°08'S, 123°55'E), (57894, 26°14'S, 121°13'E), (57905, 57907, 57909, 57911, 57915, 57917, 29°05'S, 121°22'E) USNPC # 89463, *Oochoristica australiensis*; USNPC # 89465, *Spauligodon ovifilus*; USNPC # 89466, *Abbreviata* sp (larvae).

## Appendix

Gekkonid lizards examined from Natural History Museum of Los Angeles County (LACM), with longitude and latitude and helminths deposited in the US National Parasite Collection (USNPC).

- *Diplodactylus ciliaris* (N = 31, Mean (snout-vent length) SVL = 71 mm ± 1.0 se, range = 59-82 mm) collected 1966-1968, Western Australia, LACM (56800-56802, 56804, 28°09'S, 123°56'E), (56811, 56813, 56814, 56816-56818, 56822, 56825, 56826, 56828, 56829, 56831, 56833, 56838, 56840-56842, 56845, 26°17'S, 121°00'E), (56849, 26°27'S, 119°24'E) (56854, 56856, 56857, 56859, 56860, 27°05'S, 119°37'E) (56861-56862, 27°05'S, 119°37'E); Northern Territory (56847, 21°26'S, 130°54'E). USNPC # 89440 *Maxvachonia chabandi*; USNPC # 89441, *Parapharyngodon kartana*; USNPC # 89442; *Skrjabinella machidai*; USNPC # 89443 *Abbreviata* sp (larvae).
- *Diplodactylus conspicillatus* (N = 32, Mean SVL = 59 mm ± 1.1 se, range = 48-70 mm) collected 1966-1968, Western Australia, LACM (56880, 28°30'S, 112°47'E), (56881, 56883-56885, 56889, 56890, 28°30'S, 125°50'E), (56891-56894, 56896-56901, 56903-56914, 25°20'S, 131°04'E); Northern Territory (56915, 25°20'S, 131°04'E), (56916, 22°49'S, 133°23'E), (56917, 25°12'S,